I. C. 6833 MARCH 1935

DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

SODIUM SULPHATE

O. S. U. LIBRARY

BY

PAUL M. TYLER

PLEASE DO NOT DESTROY OR THROW AWAY THIS REPORT. INSTEAD, MAIL IT TO THE BUREAU OF MINES, USING THE OFFICIAL-POSTAGE LABEL ON THE INSIDE OF THE BACK COVER.

Generated on 2024-09-18 01:41 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from
THE OHIO STATE UNIVERSITY

I.C. 6833
March 1935

INFORMATION CIRCULAR

DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SODIUM SULPHATE[1]

By Paul M. Tyler[2]

CONTENTS

	Page		Page
Foreword	2	Domestic deposits - Continued	
Description	2	Washington	18
Uses	4	Wyoming	18
Minerals	5	Domestic production	20
Mode of occurrence	7	Imports	22
Recovery from natural deposits	7	Tariff history	26
Dehydration	8	Exports	26
Manufacture of byproduct sulphate	11	The industry in foreign countries.	27
German synthetic process	12	Canada	27
Domestic deposits	13	South America	29
Arizona	13	Europe	30
California	14	Belgium	30
Colorado	15	Czechoslovakia	31
Idaho	15	Finland	31
Nevada	15	France	31
New Mexico	16	Germany	31
North Dakota	17	Great Britain	31
Oregon	17	Sweden	32
Texas	17	U. S. S. R.	32
Utah	17	Domestic consumption	32
		Market areas	33
		Prices	35

1/ The Bureau of Mines will welcome reprinting of this article, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6833."

2/ Chief engineer, Rare Metals and Nonmetals Division, U. S. Bureau of Mines.

Generated on 2024-09-18 01:44 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

FOREWORD

The United States possesses extensive supplies of sodium sulphate in numerous deposits in the Western States, and unlimited quantities could be furnished at fairly low cost in Louisiana and Texas by using common salt and sulphur as raw materials. Additional quantities might be made as a coproduct with potash and magnesium compounds from polyhalite, which occurs abundantly in New Mexico and Texas.

Until about 1925 the supply of the crude sodium sulphate or acid sulphate as a byproduct of the manufacture of hydrochloric and nitric acids in the United States tended to exceed demand, and accordingly imports and production from natural sources were inconsequential. Growing demand, notably in kraft pulp manufacture, developed coincident with a sharp curtailment in byproduct supply due to changes in the processes for making acids. Hydrochloric acid is now made to some extent by direct synthesis from gaseous chlorine and hydrogen, and nitric acid and likewise the nitrous oxides used for sulphuric acid plants, instead of being made from Chile saltpeter, are produced principally by oxidation of ammonia. As new installations at acid plants rapidly replaced the more antiquated processes the output of salt cake and more especially that of niter cake were correspondingly diminished. An impending shortage was averted in part by the exploitation of natural deposits but in greater measure by imports, especially from Germany, where the increased demand from the United States, Sweden, and other consuming countries was met by converting magnesium sulphate to sodium sulphate by suitable treatment with common salt. Previously, the magnesium sulphate liquor, formed in the processes of production of fertilizer potash, had been dumped into the rivers - not merely a waste but actually a noxious product.

A reasonable assumption is that the demand for sodium sulphate for kraft pulp, glass making, and other uses will continue its rising trend in the United States. The extent to which this favorable factor will result in expanding the production of so-called "natural" salt cake will depend, however, upon the balance of other factors, the dominant one being the cost of processing and transporting products of Western deposits to consuming plants, compared with the laid-down cost of the German synthetic product or the Canadian natural product. The issues are clearly drawn, but perhaps only time will tell what share of this expanding business domestic miners can win and hold for their own.

DESCRIPTION

Sodium sulphate occurs in commerce in three forms: (1) Anhydrous sodium sulphate, Na_2SO_4, a white amorphous powder containing no water of crystallization; (2) salt cake, a crude form of anhydrous sulphate available in powder or more typically in lumps containing 96 percent (92 to 99 percent) Na_2SO_4; and (3) Glauber's salt, $Na_2SO_4.10H_2O$, a crystalline solid containing 55 percent water of crystallization. There is also another hydrated sodium sulphate corresponding to the formula $Na_2SO_4.7H_2O$. Glauber's salt is produced either as large, transparent crystals (sp. gr., 1.462 to 1.480) or as small

Generated on 2024-09-18 01:40 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

needles similar in appearance to Epsom salts.[3] On exposure to air, the crystals lose water and turn to a white powder. Saving in transportation charges favors the use of the anhydrous salt, 44 parts of which are equivalent to 100 parts of Glauber's salt, but the crystalline salt is sometimes preferred because of its readier solubility.

Ordinary commercial sodium sulphate, or salt cake, range in color from yellowish to greenish and occasionally pure white; a dirty gray color indicates contamination by sodium chloride (incomplete decomposition). Generally speaking, the finer the grain of salt cake, the higher the grade. The following chemical analysis[4] is more or less typical of the byproduct grade:

	Percent
Moisture	0.24
Silica	.19
Iron oxide	.45
Alumina	Trace
Sodium chloride	2.15
Free sulphuric acid	1.95
Sodium sulphate (by difference)	95.02
	100.00

Niter cake, essentially sodium bisulphate (or sodium acid sulphate, $NaHSO_4$), gets its name from the fact that it is the residual product in the manufacture of nitric acid from sodium nitrate (Chile saltpeter). It is employed mainly for its acid content or as a flux but may be a source of byproduct salt cake when mixed with salt to make hydrochloric acid and for certain purposes may be considered a substitute for salt cake. Crude niter cake varies considerably in composition but ordinarily contains 30 to 35 percent free acid together with minor impurities, so that its anhydrous sodium sulphate content is roughly the same as that of Glauber's salt.

Sodium sulphide, Na_2S, has been made chiefly from salt cake, but as it is likewise a byproduct of the industries manufacturing barium chemicals, carbon disulphide (one process), and titanium pigments it may be considered a substitute for salt cake. Probably over 30 percent of the American output now comes from these new sources. So-called "crystal" sulphide of soda ordinarily contains only about 30 percent sodium sulphide, but the "fused" or "concentrated" variety (also supplied in flake form) contains 60 to 62 percent and accordingly under special circumstances might be a more economical source of the essential ingredients of salt cake in certain industries, especially the sulphate process for kraft paper making, wherein the salt cake is first reduced in part to a mixture containing sodium sulphide, sodium hydroxide, and sodium carbonate.

3/ The Chemical Catalog Co., Condensed Chemical Dictionary (2d ed.): New York, 1930.

4/ Cole, L. H., Sodium Sulphate in Western Canada: Canada Dept. of Mines, Mines Branch, No. 646, 1926, p. 62.

Generated on 2024-09-18 01:41 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Mention may be made of the 3 sulphites of soda: 1. The normal sulphite, Na_2SO_3 or $Na_2O.SO_2$; 2. the disulphite, or acid sulphite, $NaHSO_3$ or $Na_2O.2SO_2$; and 3. the meta-bisulphite, $Na_2S_2O_5$. These compounds, however, are employed commercially chiefly because they yield sulphur dioxide. They are a reducing agent, and they are not related to sodium sulphate either in use or derivation. A similar statement may be made with respect to sodium thiosulphate (more often known as "hypo"), $Na_2S_2O_3.5H_2O$, and also of the hydrosulphite, $Na_2S_2O_4$, and the hydrosulphide sulphoxylate, $NaHSO_2.CH_2O.2H_2O$.

- 3 -

In 1929, the consumption of sodium sulphate in all forms was estimated as follows:

Industry	Short tons
Pulp and paper	210,000
Heavy chemicals	70,000
Rayon and textile	50,000
Glass and ceramics	45,000
Dye and coal tar	21,000
Soap	2,000
Fine chemicals	2,000
Other	25,000
Total consumption	425,000

Corresponding figures relative to salt cake only would indicate a consumption of over 210,000 tons, of which about one third was consumed in the pulp and paper industry, one fourth in the manufacture of heavy chemicals, one fourth in the textile industry (mainly rayon), and the remainder mostly in the glass and ceramics industries. The main use is in the manufacture of kraft paper stock by the sulphate process. Niter cake, formerly regarded as a waste product and subsequently employed as a source of salt cake and as a substitute for sulphuric acid in metal pickling, absorbing ammonia, and acidifying phosphate rock), has found some application in making heavy chemicals. It has also been used very extensively in the Orford process for separating copper and nickel sulphides in the matte made from the ores of the Sudbury district, Ontario. Anhydrous sodium sulphate is used in the manufacture of ultramarine and soluble Prussian blue and in glass making, and the natural product is employed for making kraft paper; it also may be employed in making sodium carbonate, in dyeing, as a constituent of freezing mixtures, and in analytic chemistry and medicine. Glauber's salt is used mainly as a mordant in dyeing baths; it is also employed as an assistant in dyeing, in chrome tanning, as a constituent of cattle feed, and to some extent in medicine, being listed in the United States Pharmacopoeia (1926) as a purgative. A definite trend has developed to replace Glauber's salt with refined anhydrous sulphate, notably as diluent in the manufacture of dyes,

---

5/ U. S. Tariff Commission, Summary of Tariff Information, 1929: Sched. 15 (Free List), p. 2889.

Generated on 2024-09-18 01:44 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

because of the cost of transporting the water of crystallization which serves no useful purpose except to facilitate dissolving. Among the heavy chemicals made from the various cruder kinds of sodium sulphate are water glass, sodium sulphide, sodium thiosulphate, and of course Glauber's salt and refined anhydrous sulphate; salt cake was likewise an intermediate step in the production of hydrochloric acid and sodium carbonate from salt and sulphuric acid by the famous, though fast disappearing, Leblanc process.

MINERALS

Sodium sulphate occurs in nature as the anhydrous mineral thenardite and in hydrated forms as mirabilite; it also occurs as a constituent of several double sulphates and more complex minerals. Thenardite and mirabilite and possibly glauberite are the principal minerals. Thenardite is often found massive without recognizable crystalline form; it dissolves easily in water and has a faintly saline taste. Mirabilite forms long, needlelike crystals which effloresce readily in dry air, falling to a white powder; its taste is slightly bitter. Glauberite dissolves in water with deposition of gypsum as a white powder and generally exhibts some effervescence with acid.

The properties of the principal sodium sulphate minerals are summarized in the accompanying table. Other minerals, none of which have more than mineralogical significance, that contain sodium sulphate are the following:

Ferronatrite ..... $3Na_2SO_4.Fe_2(SO_4)_3.6H_2O$.
Loeweite ..... $2Na_2SO_4.2MgSO_4.5H_2O$.
Mendozite ..... $Na_2SO_4.Al_2(SO_4)_3.24H_2O$.
Natrochalcite ..... $Na_2SO_4.Cu_4(OH)_2(SO_4)_2.2H_2O$.
Natrojarosite ..... $Na_2SO_4.2Fe_2(OH)4SO_4$.
Sideronatrite ..... $2Na_2SO_4.Fe_2(OH)_2(SO_4)_2.6H_2O$.
Sulphohalite ..... $2Na_2SO_4.NaCl.NaF$ (slightly soluble).
Tamarugite ..... $Na_2SO_4.Al_2(SO_4)_3.12H_2O$.

Generated on 2024-09-18 01:41 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 01:44 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from THE OHIO STATE UNIVERSITY

Properties of the principal compounds of sodium sulphate

Properties	Mirabilite	Thenardite	Aphthitalite	Bloedite	Glauberite	Hanksite
Formula	$Na_2SO_4.10H_2O$	Na_2SO_4	$(Na,K)_2SO_4$	$Na_2SO_4.MgSO_4.4H_2O$	$Na_2SO_4.CaSO_4$	$9Na_2SO_4.2Na_2CO_3.KCl$
Specific gravity	1.48	2.68	2.64	2.25	2.7 - 2.85	2.56
Hardness	1.5-2	2.5	3-3.5	2.5	2.5 - 3	3 - 3.5
Luster	Vitreous	---	Vitreous, inclining to resinous	Vitreous, clear, glassy colorless fragments resemble quartz fragments in appearance	Vitreous	Vitreous
Cleavage	Perfect	Basal, Distinct	Distinct	None	Basal, perfect	Basal, distinct
Crystallization	Monoclinic	Orthorhombic	Hexagonal rhombohedral	Monoclinic	Monoclinic	Hexagonal
Opticity	Negative	Positive	Uniaxial positive	Negative	Negative	Uniaxial, negative
Indices of refraction ...	α = 1.394 β = 1.396 γ = 1.398	α = 1.464 β = 1.474 γ = 1.485	Slightly variable with composition ω = 1.49 ε = 1.50	α = 1.486 β = 1.488 γ = 1.489	α = 1.515 β = 1.532 γ = 1.536	ω = 1.481 ε = 1.461

MODE OF OCCURRENCE

Sodium sulphate is a constituent of sea water, and in fact virtually no natural waters are wholly free from sulphates. Deposits of commercial interest, however, are formed only in arid regions, the great closed basins where rainfall is deficient and the streams have no outlet to the ocean. Sodium sulphate is a minor constituent of soils, and where rainfall and drainage are subnormal it may accumulate in notable quantity, producing "white alkali" soils. The complex reactions that may result in the development of this compound, however, are of little importance except to geologists, and geologists do not agree as to the mechanism of origin of many deposits.6/ The principal point of economic interest is the fact that natural deposits, due to their origin, are mostly in regions incapable of sustaining large agricultural or even industrial communities. In other words, they are characteristically remote from markets and from sources of labor and requisite supplies, and their exploitation is correspondingly handicapped by relatively high freight and production costs. In a few places sodium sulphate minerals are present in dry beds of minable thickness and are not unduly mixed with other salts and mud. Typical occurrences are in "playas", which are dry or marshy bottoms of more or less dried-up salt lakes, ranging in size from small sloughs with a scanty encrustation of salts on the surface of the mud to thick beds several miles in extent. In such deposits the sodium sulphate, frequently mixed with other soluble salts, may occur (1) in solution as a brine of varying degrees of saturation, (2) in an intermittent crystal layer, or (3) as a permanent bed protected from solution in wet weather by a covering of mud. At many places the intermittent crystal formations are most important. During the fall and even on cool nights in the summer, sodium sulphate crystals are deposited from heavily charged brine; and these crystals, often quite pure, can be harvested repeatedly. Even in Great Salt Lake (which of course contains quantities of common salt as well as numerous other compounds with only a relatively small concentration of sodium sulphate) there is a salting out of sodium sulphate crystals in extremely cold weather.

RECOVERY FROM NATURAL DEPOSITS

Near Camp Verde, Ariz.,7/ a flat-lying bed of thenardite 4½ feet thick is worked through a tunnel in 100-foot blocks. The salt is drilled with machines and after being shot down is loaded into cars with a hoe-type scraper. The ground stands well, and a little timber is required. Material as mined is contaminated with clay and sodium chloride, which are removed by a 5-mesh cylindrical screen, 25 feet long, equipped with sprays and employing a saturated sodium sulphate solution instead of water. A drum drier removes moisture, and rolls are employed to crush the sulphate to 1/4 inch. A typical analysis of the finished product is as follows: Insoluble, 2.68 percent; $CaSO_4$, 1.63 percent; NaCl, 0.55 percent; Na_2SO_4, 95.14 percent.

6/ Grabau, A. W., Principles of Salt Deposition: New York, vol. 1, 1920.
7/ McDermid, A. J., Meeting the Demand for Sodium Sulphate: Eng. and Min. Jour., vol. 135, no. 4, April 1934, p. 164.

Generated on 2024-09-18 01:45 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

In Utah it has been planned to mine a deposit of Glauber's salt in open pits. Instead of ordinary drilling, holes may be melted out for blasting by steam points. The refining process employs a steam-jacketed mixer followed by a 45-inch Akins classifier, which eliminates the sands (largely calcium carbonate). The solution is heated and purified further by filtering before going to a forced-circulation-type evaporator, the crystals from which are centrifuged and washed.8/

Deposits of impregnated clays may be often worked in arid climates by alternate flooding and evaporating in ditches (or solar pans). In most climates the product thus recovered is Glauber's salt, but the American Sodium Co., at Wabuska, Lyon County, Nev., was able to produce an anhydrous product. According to H. I. Smith of the U. S. Geological Survey (private communication), this company's deposit lay in a natural basin which could be flooded in winter. The water, which soon became saturated in sodium sulphate, collected in shallow ditches and evaporated in the dry season, the surface crust being broken up and harvested very much like ice. In a normal season the temperature would remain above 80° F. when the first seed crystals formed, in which case a fair quality of anhydrous salt was produced, but if the temperature dropped even to 76° F. at this critical period a hydrated product separated out.

A patent9/ has been issued on a method of leaching natural beds of sodium sulphate with shallow streams of water during the day, the leach liquors accumulating in a reservoir in the bed, in which reservoir Glauber's salt crystallizes during the night.

In Canada, 3 methods of production have been employed. According to the nature of the deposit and other factors, it has been possible (1) to mine the bed, (2) to "fish" crystals out of the brine, or (3) to evaporate the brine. In the late summer the brine in deposits becomes concentrated enough so that intermittent beds of crystals form which can be harvested, sometimes with a steam shovel. In the "fishing" operations the crystals are loaded into scows that are floated over the deposits; this method is slow and is recommended only when the rate of production is small, but it yields almost pure crystals without further treatment. The product from an intermittent bed likewise may be rather pure, but any method, whether mining or "fishing", that depends upon intermittent crystals is naturally limited in application to a short harvesting season, only a few months at most each year. Methods that depend upon permanent beds or evaporation of brine involve chemical processes of purification to eliminate soluble as well as insoluble impurities.

DEHYDRATION

Glauber's salt is the most feasible product to recover from many natural deposits, but as the market for this decahydrate is quite limited it

8/ Martin, G., Meeting the Demand for Sodium Sulphate: Eng. and Min. Jour., vol. 135, no. 4, April 1934, p. 165.

9/ Warnken, A. T. W. (assr. to E. Johnson), Obtaining Sodium Sulphate from Natural Deposits: U. S. Patent 1798993, Mar. 31, 1931.

Generated on 2024-09-18 01:39 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

will be necessary in most cases to dehydrate the crystals, obtaining the anhydrous salt. The difficulties of this operation are due to several properties of Glauber's salt. Its melting point is 32.4° C. (90° F.), where anhydrous sodium sulphate and a saturated solution of sodium sulphate are formed. Above this temperature the solution of sodium sulphate has an inverted solubility curve; that is, the salt becomes less soluble with increasing temperature, thereby inducing formation of scale and other difficulties during evaporation. Ordinary air drying helps somewhat, and some success has attended the use of spray-drying devices to avoid the formation of sulphate scale on the heating surfaces of the evaporator. The maximum solubility of sodium sulphate is at 90° F.; and, because of the peculiar solubility curve of anhydrous salt-decahydrate mixtures, even at this temperature 2 tons of water have to be removed for each ton of anhydrous salt produced.

Some work on this problem has been done at the New Brunswick (N.J.) Station of the Bureau of Mines as a phase of the work on polyhalite. The reader is also referred to the monograph by Cole[10/] and to a more recently published patent survey (incomplete) from which the following abstracts are taken:[11/]

John Davis, in U. S. Patent 990116 (April 18, 1911), mixes the decahydrate crystals with a porous vehicle incapable of dissolving in the melted crystals at a temperature sufficient to evaporate the moisture. The purpose of the porous vehicle is to prevent the formation of a fluid mass when the sodium sulphate dissolves in its water of crystallization on the application of heat. Sufficient vehicle is present so that with agitation the mass is kept in a semidry condition. The resulting product of dry vehicle and dehydrated sodium sulphate can be treated mechanically or chemically to separate the salt from the vehicle. However, the inventor prefers to use a vehicle consisting of ingredients which, when combined with the sodium sulphate and fused, will produce glass or one of the sodium salts ordinarily made from sodium sulphate. For glass, the vehicle is sand and lime; for sodium carbonate, the vehicle is limestone and coal.

C. W. Hancock and C. Ide, in Canadian Patent 216621 (March 14, 1922), made use of the fact that sodium sulphate is practically insoluble in sodium chloride solutions. Sodium chloride is introduced into a saturated solution of sodium sulphate, formed either by melting the decahydrate at 33° C. or by dissolving it in excess water. The sodium sulphate is precipitated out as the anhydrous salt and is removed and dried. The solution is evaporated to recover the sodium chloride.

10/ Cole, L. H., Sodium Sulphate of Western Canada: Canada Dept. of Mines, Mines Branch, no. 646, 1926, pp. 49-55.

11/ Kobe, K. A., and Hauge, C. W., Sodium Sulphate from Natural Deposits: Can. Chem. and Met., vol. 18, no. 8, August 1934, p. 177.

Generated on 2024-09-18 01:39 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

J. W. Hill, in Canadian Patent 261891 (June 22, 1926), heats a solution of sodium sulphate saturated at 32.4° C. to a temperature of approximately 100° C. The inverted solubility curve of the salt causes a portion of the salt to precipitate as the anhydrous salt.

Arthur Lambert, in U. S. Patent 1660561 (February 28, 1928), treats a natural brine containing sodium sulphate, chloride, and carbonate with ammonia and carbon dioxide, precipitating sodium bicarbonate as in the Solvay process.

H. L. Robson, in Canadian Patent 268056 (February 1, 1927), treats the Glauber's salt in a closed vessel with ammonia vapor and separates the anhydrous sodium sulphate from the ammoniacal liquor. The ammonia is recovered and reused.

W. H. Dickerson, in U. S. Patent 1734289 (November 5, 1929), discloses an apparatus suitable for the spray drying of sodium sulphate solutions.

G. F. Anderson, in Canadian Patent 295435 (December 10, 1929) and U. S. Patent 1751901 (March 25, 1930), has patented what appears to be the natural process of crystallization of the hydrated salt from its brine. In U. S. Patent 1913470 (June 13, 1933) he has a dehydrating process and apparatus in which the pulverized salt is subjected to air of increasing temperature until all the moisture is removed without having the decahydrate melt.

A. T. W. Warnken, in U. S. Patent 1798993 (March 31, 1931), obtains anhydrous sodium sulphate by treating the deposit of Glauber's salt with fresh water, subjecting the water to the natural temperature conditions of day and night so that the solution process during the day produces a dense solution which naturally gravitates towards a central vat where crystallization occurs during the cool night. The heat of the day apparently melts the deposited crystals to give the anhydrous salt, as it is claimed that this is removed.

L. E. Drummond, in Canadian Patent 314908 (September 1, 1931), has a cyclic process in which the Glauber's salt is first melted at 32.4° C., the saturated solution removed to a cooling zone and Glauber's salt recrystallized from the solution. The salt is put through the process again and the mother liquor cooled to deposit more crystals.

W. F. Seyer, in Canadian Patent 319415 (February 2, 1932), crushes the wet decahydrate crystals to 0.5 to 2.0 mm diameter, slowly mixes 3 parts by weight of the ground decahydrate with 5 parts by weight of dry sodium sulphate at a temperature of 30° F., and then dries the mixture in a rotary drum drier. Thus when the decahydrate crystals melt there is sufficient dry salt present to give the mixture sufficient consistency to prevent the formation of a crust of sodium sulphate on the inside of the drier.

Generated on 2024-09-18 01:35 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

J. B. Pierce, Jr., in U. S. Patent 1886580 (November 8, 1932), has a process similar to that of Seyer. He mixes with the saturated solution of sodium sulphate a sufficient quantity of dehydrated sodium sulphate to convert the mass to a substantially solid phase corresponding to the condition of damp sand in order to prevent the liquefaction or caking of the mass when heated at an elevated temperature in a rotary drier until the salt is anhydrous.

Near Oban, Saskatchewan, an experimental plant was operating in 1933 on a new system of dehydration in which anhydrous sodium sulphate is precipitated under a system of temperature control; other Canadian plants have used direct evaporating, starting with Glauber's salt.

MANUFACTURE OF BYPRODUCT SULPHATE

Hydrochloric acid has been made chiefly by the interaction of niter cake with salt (sodium chloride), with the simultaneous production of salt cake. In the United States the Mannheim mechanical salt cake furnace has entirely superseded the older pot-and-muffle method (a remnant of the Leblanc process for soda ash), and in other countries mechanical furnaces have likewise displaced the older, laborious, and generally discontinuous operations.12/ The yield of salt cake by this process is slightly greater than the tonnage of niter cake charged. The process may be modified somewhat by adding sulphuric acid and the decreased supply of niter cake, due to the decrease in the use of the retort process for making nitric acid, has hastened the adoption of synthetic processes based upon direct combination of elemental hydrogen and chlorine from electrolytic cells. A fairly large proportion of this domestic output of hydrochloric acid is even now of synthetic origin. Hydrochloric acid is likewise a byproduct of the chlorination of organic materials, chiefly of coal tar origin. All these changes in the hydrochloric acid industry have tended to reduce the output of byproduct salt cake, a subject that will receive more serious attention later. The Hargreaves process yields salt cake and hydrochloric acid from salt and sulphur dioxide, according to the following reaction:

$$2NaCl + SO_2 + O + H_2O = Na_2SO_4 + 2HCl.$$

This process made considerable progress in Europe several decades ago and has been employed for several years by the Myles Salt Co. in Louisiana.

The manufacture of salt cake and hydrochloric acid from sulphuric acid and salt has to be conducted in 2 stages, the bisulphate (cf. niter cake) being an intermediate product as indicated by the following equations:

$$(1)\quad NaCl + H_2SO_4 = NaHSO_4 + HCl.$$
$$(2)\quad NaCl + NaHSO_4 = Na_2SO_4 + HCl.$$

12/ Riegel, E. R., Industrial Chemistry: New York, 1928, pp. 48-54. (Gives details of process.)

Generated on 2024-09-18 01:40 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The first reaction starts at ordinary temperatures, but the second is only completed at a red heat (but not to exceed 800° C., the melting point of ordinary salt cake). Coarse-grained salt, such as pan salt, and chamber acid (sp. gr. 1.7 to 1.72) are usually employed, and operations at pot-and-muffle plants are described as follows:13/

> The salt is generally treated in batches of about half a ton, in a large, hemispherical, direct-fired pan, set in suitable brickwork. To the salt an equal weight of sulphuric acid is added. The hydrochloric acid evolved in the decomposing pan is drawn off through a flue in the dome of brickwork covering the pan and is absorbed by water.
>
> The hot mass is then raked into a muffle or reverberatory furnace, and the reaction is completed at a higher temperature. The hydrochloric acid evolved in the muffle furnace is collected separately. When no more vapors are seen rising in the muffle furnace the batch is drawn out and usually left to cool in a closed box in order to avoid the nuisance of obnoxious gases.
>
> The yield of salt cake by this process will vary in different plants, 115 pounds of salt cake per 100 pounds of original salt being an average recovery.

The largely discontinued process of manufacture of byproduct niter cake is of interest, both as a source of sodium sulphate in the Mannheim process and because it is something of a competitor of salt cake. It is produced in the manufacture of nitric acid from Chilean nitrate of soda and sulphuric acid; for making 90-percent nitric acid, high-strength sulphuric acid (90 to 94 percent H_2SO_4) is required, but for 80-percent nitric acid, 78 percent H_2SO_4 (Glover acid) is suitable. By employing quite high temperatures it might be possible to produce anhydrous sodium sulphate and nitric acid, thereby consuming all the sulphuric acid charged, but as this would not be economical it is customary to use more sulphuric acid and conduct the operation approximately according to the following equation:

$$NaNO_3 + H_2SO_4 = NaHSO_4 + HNO_3.$$

The operation is carried on in cast-iron retorts under a vacuum, and when it is completed the niter cake is tapped molten from the bottom of the retorts either into molds or in a stream to be granulated by an air blast.

GERMAN SYNTHETIC PROCESS

This process for converting waste magnesium sulphate from potash works into saleable salt cake is based upon the equation:

$$MgSO_4 + 2NaCl = Na_2SO_4 + MgCl_2$$

Common salt is added at suitable temperature and solution control conditions are of course required.

13/ Cole, L. H., work cited, p. 59.

Generated on 2024-09-18 01:41 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

DOMESTIC DEPOSITS

The supply of natural sodium sulphate in the Western United States is virtually inexhaustible, and known reserves are of the magnitude of hundreds of millions of tons. The development of new properties and the continued operations of existing mines accordingly are limited strictly by market conditions. Commercial production of natural sodium sulphate and Glauber's salt to date has been confined principally to Arizona, California, Texas, Nevada, Utah, and Wyoming. There has been a small production from Washington, and deposits in New Mexico have likewise received some commercial attention. In addition to what may be described as high-grade deposits, mention might be made of reports of substantial sodium sulphate contents in numerous springs and lakes in the Western States and of the possibility of recovering sodium sulphate as a byproduct of potash salts manufacture from polyhalite in New Mexico and Texas, as well as in California. The vastness of available sources of supply may perhaps be comprehended more clearly when it is recognized that Great Salt Lake alone is said to contain 30,000,000 tons of sodium sulphate, and its 400,000,000 tons of salt (sodium chloride) might likewise be converted into sulphate by the sulphur dioxide discharged into the atmosphere by nearby smelters.

Arizona

By far the largest producer of natural sodium sulphate in the United States has been the Arizona Chemical Co., a subsidiary of the American Cyanamid Co. (535 Fifth Ave., New York, N. Y.), which has operated 1½ miles southwest of Camp Verde, Yavapai County, under lease from the Sodium Products Co. According to McDermid,[14] the sulphate is contained in a 4½-foot, flat-lying bed which outcrops along the west side of the valley of the Verde River and is a member of a thick series of sediments consisting chiefly of clays, sodium chloride, sodium sulphate, and calcium sulphate. According to Young,[15] the more or less irregular beds of thenardite associated with mirabilite, glauberite, and rock salt are in the Verde formation and have been exposed over a relatively small area by erosion. This formation covers a wide area east of Clarkdale and east of the Verde River Valley generally. The sodium sulphate deposits occur where this formation is thickest and represent the final evaporation of the concentrated brine that marked the last stages of a Tertiary lake. The deposit was leased for some years to the Western Chemicals, Inc., of Los Angeles and has been worked intermittently by other operators over a period of 45 years or more. The most recent underground mining operations and the milling methods are outlined on a previous page; formerly the deposit was worked opencut by gasoline shovels. From all accounts this is a very large deposit, and the principal reason that it has not been worked profitably over a longer period of time is the cost of transportation. As late as 1927 it is reported that haulage of the product to railroad cost $3.50 a ton. Subsequently 2½-ton Mack trucks built up to hold 7 tons have been employed to carry the product to Clemenceau, the nearest railroad shipping point, but recent trucking costs per ton are not available. However,

---

14/ McDermid, A. J., work cited, p. 164.

15/ Young, G. J., Mining Sodium Sulphate at Camp Verde, Ariz.: Eng. and Min. Jour., vol. 124, no. 3, July 16, 1927, pp. 97-8.

Generated on 2024-09-18 01:38 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

in December 1933, it was reported[16] that the property once more had to shut down due to inability to meet competition from California and Europe; 6 months earlier production was going forward full speed at the rate of around 3,000 tons monthly. Another deposit in this same general area has been opened up and may be operated if market conditions improve.

California

Thenardite has been reported as present in substantial quantities in Imperial County (2½ miles from Pope Siding) and in San Bernardino County (Searles Borax Lake); other occurrences are in Inyo County at various localities and in San Luis Obispo County (between the Caliente and Temblor Ranges). Hydrous sodium sulphate minerals are found in association with various dry salt basins. Considerable data regarding these various occurrences will be found in the footnote references listed below.[17] From a commercial standpoint, however, Soda Lake in San Luis Obispo County and Searles Lake in San Bernardino County are apparently of chief interest. The former is a deposit of mirabilite or Glauber's salt (along with a little bloedite), which in dry seasons dehydrates to a white powder, covering nearly 3,000 acres and containing over a million tons of crude sodium sulphate salts. The deposit is 16 miles from McKittrick, a station on a branch line of the Southern Pacific Railway; this is the nearest railroad shipping point and is reached by a winding road with steep grades crossing the Temblor Range. It was worked intermittently for a number of years; and shipments of dried salts containing around 90 percent sodium sulphate have been made, but no output from this lake has been reported recently.

16/ Mining Journal (Arizona), Arizona Chemical Co.: Vol. 17, no. 14, Dec. 15, 1933, p. 10.

17/ Wells, R. C., Sodium Sulphate; Its Sources and Uses: U. S. Geol. Survey Bull. 717, 1923, p. 19.
Tucker, W. B., Los Angeles Field Division; Imperial County; Sodium Sulphate: California State Mineralogist Rept., vol. 20, no. 2, April 1924, pp. 87-91, also vol. 22, no. 2, April 1926, pp. 281-3.
Gale, H. S., Salines in the Owens, Searles, and Panamint Basins, Southeast California: U. S. Geol. Survey Bull. 580, 1915, pp. 251-64.
Russell, I. C., Quaternary History of Mono Valley: U. S. Geol. Survey 8th Annual Rept., pt. 1, 1889, pp. 269-394.
Lee, W. T., Geology and Water Resources of Owens Valley, California: U. S. Geol. Survey Water Supply and Irrigation Paper 181, 1906, p. 23.
Tucker, W. B., and Sampson, R. J., Los Angeles Field Division; Soda: California State Mineralogist Rept., vol. 27, no. 3, July 1931, pp. 397-9.
Laizure, C. McK., San Francisco Field Division; Sodium Sulphate: California State Mineralogist Rept., vol. 21, no. 4, October 1925, pp. 535-6.
Arnold, Ralph, and Johnson, H. R., Sodium Sulphate in Soda Lake, Carriso Plain, San Luis Obispo County, Calif.: U. S. Geol. Survey Bull. 380, 1909, pp. 369-71.

Generated on 2024-09-18 01:38 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

At Searles Lake, sodium sulphate occurs rather abundantly, both in the solid state and in brines. Processes for recovering borax and potash salts from the brine entail early removal of "burkeite" (sodium sulphate, sodium carbonate, and water in molecular properties), but it was not thought worth while to separate the sulphate until recently. Late in 1933, however, the American Potash & Chemical Corporation awarded a contract for a three-story building. The daily capacity of this $1,250,000 plant is estimated at 100 tons of soda ash and 125 tons of salt cake.

Colorado

Various ponds and springs in Jefferson and El Paso Counties, Colo., are mentioned in early reports[18] as containing more or less sodium sulphate, generally accompanied by carbonate of soda.

Idaho

Mixtures of Epsom and Glauber's salts with common salt occur on Jump Creek in Owyhee County, Idaho, and westward intermittently into Malheur County, Ore., where more or less work has been done, chiefly in search of nitrates.[19]

Nevada

Saline lakes and playas containing sodium sulphate have been recorded[20] at the following localities in Nevada: West of Humboldt Sink and from Buena Vista Valley in Pershing County; Smoke Creek Desert in Washoe County; Big Smoky Valley in Esmeralda County; and near Mina in Mineral County. It has also been reported in the water at Sou Hot Springs, Buena Vista Valley, Pershing County; in Hot Springs near Wabuska, Lyon County; and in Walker Lake, Mineral County. It is also found associated in many of the Nevada saline marshes. The reader is referred to the footnote references[21] for available information on many of these occurrences.

18/ Wells, R. C., work cited, p. 21.
Wilson, J. S., General Land Office Rept. for 1870, p. 120.
Smith, J. A., Colorado State Geologist, Rept. for 1881-82, 1883, p. 117.

19/ Mansfield, G. R., Nitrate Deposits in Southern Idaho and Eastern Oregon: U. S. Geol. Survey Bull. 620, 1916, p. 31.

20/ Fulton, J. A., and Smith, A. M., Nonmetallic Minerals in Nevada: Pit and Quarry, vol. 24, no. 11, Aug. 24, 1932, p. 37.

21/ Wells, R. C., work cited.
Chatard, T. M., Natural Soda; Its Occurrences and Utilization: U. S. Geol. Survey Bull. 60, 1890, pp. 46-53.
King, C., U. S. Geol. Explorations 40th Parallel Rept., vol. 1, 1878, pp. 510-13; vol. 2, pp. 746-50.
Russell, I. C., History of Lake Lahontan: U. S. Geol. Survey Mon. 11, 1885, pp. 8-51 and 73-80.
Hague, Arnold, King's Rept. 40th Parallel, vol. 2, 1877, p. 749.
Dole, R. B., Exploration of Salines in Silver Peak Marsh, Nev.: U. S. Geol. Survey Bull. 530, 1913, pp. 330-45.
Melhase, J., Mining Mirabilite Near Wabuska, Nev.: Eng. and Min. Jour.-Press, vol. 119, no. 24, June 13, 1925, pp. 965-7.
Young, G. J., Potash Salts and Other Salines in the Great Basin Region: U. S. Dept. Agriculture Bull. 61, 1914, p. 54.

Generated on 2024-09-18 01:41 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Rhodes Marsh in Mineral County, near Mina, comprises an area of 11 square miles and contains several million tons of available sodium sulphate. After 2 years of experimentation the Rhodes Alkali & Chemical Corporation (Balboa Bldg., San Francisco, Calif.) erected a plant on this property in 1930. In 1932, railroad connection was made with an industrial spur of the Southern Pacific Railway, eliminating former trucking costs, and production was stepped up to 50 or more tons a day of (anhydrous) salt cake. The plant and operations have been described by Rich,22/ who indicates that only a thenardite layer, 3 to 5 feet thick, is mined; previous operations were in the mirabilite or Glauber's salt portions of the deposit. The ground product has been shipped mostly to Louisiana and California, and early in 1934 the plant remained closed due to lack of market at profitable prices.

For a number of years the leading Nevada producer of sodium sulphate was the American Sodium Co., whose plant and deposit are 2 miles east of Wabuska, Lyon County. The floor of the Mason Valley, formerly an embayment of the ancient Lake Lahontan, is covered by recent alluvial silt underlain by beds of saline clay. Mirabilite occurs as a playa deposit covering several square miles, east and north of Wabuska, and the Government lease (issued to Arthur Warnken) covers 1,440 acres situated in T. 15N., R 15E, M. D. M. The whole area is impregnated with hydrous sodium sulphate, and there are numerous depressions of alkali flats. Water for periodically flooding the deposit is obtained from nearby wells at a depth of 60 to 80 feet.

Attention has been also directed to a deposit of glauberite, containing 2 to 4 million tons, on what will be the western shore of the reservoir above Boulder Dam, 4½ miles southwest of St. Thomas; in the course of perhaps 10 years it may be wholly flooded, but underground extensions may be found that will not be affected by the lake.23/

New Mexico

In 1919 the Southern Chemical Co., El Paso, Tex., undertook experimental work on the production of anhydrous sodium sulphate from a deposit in Dona Ana County, N. Mex., about 25 miles by road, west of Valmont, a station on the main line of the El Paso & Southwestern Railway 10 miles south of Alamagordo and about 80 miles north of El Paso. The Great Southern Sulphur Co., a New Orleans concern, later took over the property, but no actual production has been recorded. The White Sand plains in the Tularosa Basin are composed mainly of gypsum; and the underlying soil is impregnated with sodium sulphate, with the result that ground water, which is said to rise close to the surface in pits dug in the lowest parts of the flat, becomes saturated with Glauber's salt. Bloedite and mirabilite have been reported at Laguna Salina, Torrance County, but not in commercial quantities.

22/ Rich, P. C., Sodium Sulphate from Nevada Mine Finds Ready Market: Eng. and Min. Jour., vol. 134, no. 6, June 1933, pp. 252-3. (Also Chem. and Met. Eng., vol. 40, no. 6, June 1933, pp. 304-5.

23/ Carpenter, J. A., and Smith, A. M., Electrochemical Industries at Hoover Dam: Min. and Met., vol. 13, no. 308, August 1932, p. 361.

Generated on 2024-09-18 01:35 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

North Dakota

A field survey being conducted by 25 men on the Federal Emergency Relief rolls of the State has already disclosed the presence of 8 deposits of Glauber's salt in the northwestern part of North Dakota, close to lignite supplies and railroad facilities. The largest and most extensive of these deposits is reported to contain 10 million tons over an area of 600 acres. Typical analyses are given showing over 95 percent Na_2SO_4, but the reference[24] does not state that water of crystallization has been removed. From 1.6 to 3.3 percent of $MgSO_4$ is reported but other impurities are rather low.

Oregon

The saline deposits of the southeastern lake region of Oregon are considered a resource of probable future importance, and sodium sulphate is a prominent constituent of the waters of some of the lakes in Harney and Lake Counties. Mansfield[25] has described the geology adjacent to Sucker Creek claims in Malheur County, where some low hills have been found to carry beds of Glauber's salt, 2 feet or more thick, partly effloresced in the upper 3 or 4 inches.

Texas

In 1933, the Ozark Chemical Co. (Tulsa, Okla.) began producing salt cake from the waters of Soda Lake, 11 miles or more south of the railroad at Monahans, not far from Gail, Ward County, Tex. The plant, estimated to cost $350,000, was reported[26] to employ a freezing process. Wells[27] stated that this lake covers 160 acres and was said to contain an upper layer of crystallized salts, chiefly Glauber's salt, 3 to 6 feet thick, and a lower layer, under 30 feet of red clay. The present operators explored the deposit by drilling before building a plant.

Utah

Manufacture of anhydrous sodium sulphate from a bed of Glauber's salt lying along Great Salt Lake, 16 miles west of Salt Lake City, was begun in 1934 by the Sodium Products Co.[28] The company operates under a sublease from the Great Salt Lake Chemical Co., organized by J. H. Marshall and assignees of his lease from the State. It controls 700 acres of lake bottom, under which lies a bed of crude Glauber's salt 2 to 30 feet thick, covered by an overburden of 18 to 48 inches of clean lime sand. The salt as mined contains around 22 percent Na_2SO_4, only about 1½ percent NaCl and other water-soluble

---

24/ Industrial and Engineering Chemistry (News Ed.), Survey Reveals Vast Deposits of Glauber's Salt: Vol. 12, no. 21, Nov. 10, 1934, p. 396.

25/ Mansfield, G. R., Nitrate Deposits in Southern Idaho and Eastern Oregon: U. S. Geol. Survey Bull. 620, 1915, pp. 20-5.

26/ Industrial and Engineering Chemistry (News Ed.), New Sodium Sulphate Plant: Vol. 10, no. 21, Nov. 10, 1932, p. 270.

27/ Wells, R. C., work cited.

28/ Martin, Gail, Salt Lake Company Working Bed of Glauber Salt: Eng. and Min. Jour., vol. 135, no. 4, April 1934, p. 165.

Generated on 2024-09-18 01:36 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

impurities in small amount. This is part of the Saltair deposit which extends several miles along the southern shore of the lake and which has been exploited sporadically by several companies, including the Midwest Dye & Chemical Co., whose operations were described in some detail by Jones.[29] The piles of the pavilion at Saltair Beach resort are said to have been sunk in 30 feet of hardpan consisting mainly of hydrated sodium sulphate crystals mixed with sand. The whole deposit has been estimated to contain several million tons of sodium sulphate crystals. Great Salt Lake itself has a mineral-salt content of 23 percent, of which 3¾ percent is sodium sulphate. When the temperature drops toward freezing and where wave action and fresh water inlets do not interfere, crystals of Glauber's salt separate out and sink. Small quantities of these intermittent crystals are washed ashore and occasionally have been harvested.

Washington

Many small ponds and saline deposits containing sodium sulphate are found in the hilly region along the Okanogan River. Lakes in Kruger Mountain, west of Oroville, near the Canadian border, have yielded considerable quantities of Epsom salt ($MgSO_4 \cdot 7H_2O$), which fact may be significant in view of the observation that magnesium is a more prominent constituent in the Canadian saline lakes generally than it is in the arid regions of the United States. The water of Omak Lake, also in Okanogan County, is essentially a solution of sodium carbonate and sulphate but is rather dilute. Wells,[30] however, estimated about 1,300,000 tons of these salts as present in this lake. Soap Lake and other so-called alkali lakes in Grant County are deemed too dilute for direct commercial utilization.

Washington has never contributed more than a small and erratic commercial output of sodium sulphate, but several enterprises have been projected as promising. Among the latest is a proposal for a plant near Monse, Oreille County, in connection with a paper pulp mill at Priest River, Idaho; dry lake beds near Monse on the Colville reservation, controlled by the company, were reported[31] to contain unlimited supplies of raw material.

Wyoming[32]

Hydrated sodium sulphate (Glauber's salt) has been produced in Wyoming with some regularity for several years from deposits near Caspar, Laramie

---

29/ Jones, C. H., Sodium Salts chapter: Mineral Industry during 1920, 1921, pp. 634-35.

30/ Wells, R. C., work cited, p. 28.

31/ Rock Products, To Build Sodium Sulphate Plant: Vol. 35, no. 2, Jan. 30, 1932, p. 52.

32/ Dietz, C. S., Electrometallurgical Resources of the North Platte River Basin, Wyoming: Wyoming Geol. Survey Bull. 23, 1932, pp. 160-83.
Wells, R. C., work cited, pp. 28-31.
Knight, W. C., and Slossen, E. E., Alkali Lakes and Deposits: Univ. Wyoming Sta. Bull. 49, June 1901, pp. 90-2.
Schultz, A. R., Deposits of Sodium Salts in Wyoming: U. S. Geol. Survey Bull. 430, 1910, p. 577.
Darton, N. H., and Siebenthal, C. E., Geology and Mineral Resources of the Laramie Basin, Wyo.: U. S. Geol. Survey Bull. 364, 1909, pp. 63-4.

Generated on 2024-09-18 01:36 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

County, and more recently also from near Rawlins, Carbon County. The former are among the most favorably situated deposits in the United States as regards transportation. One of the sources exploited by the Pratt Sodium Sulphate Co. in this section is a private lake located about 4 miles east of Caspar and only ½ mile north of the loading racks on the Chicago & Northwestern and Chicago, Burlington & Quincy Railroads. Past operations indicate the inflow of this small lake at 1,000 tons of sodium sulphate annually. The main production of this company, a leasing unit of the Gill Soda Co., has been derived from Gill Lake, which lies 8 miles northeast of Casper; the top seam of sulphate at this deposit is 10 feet thick and is mined by a clam-shell bucket. For several years the Columbian Hog & Cattle Powder Co. of Kansas City, Mo., has been shipping Glauber's salt from a dry lake bed about ½ mile from Sodium, a railway station in Natrona County, about 30 miles northwest of Casper. This deposit, which is likewise owned by the Gill Soda Co., is estimated to contain fully 250,000 tons of available sulphate, and the numerous deposits, many of which have never been worked, in this general vicinity of Casper unquestionably represent a very large tonnage. John D. Gill, for many years a prominent figure in sodium sulphate developments in this territory, was reported deceased in 1932, and his affairs have subsequently been administered by Mrs. Elizabeth G. Taulbee, Hollywood, Calif.

Recent operations near Rawlins have been conducted by the Iowa Soda Products Co., and the product has been shipped to Council Bluffs, Iowa, for refining.

The Union Pacific Lakes, about 13 miles southwest of Laramie, in Albany County, comprise a group of four fairly large lakes and innumerable depressions covering an area of many acres. The formation is described[33] as a body of Glauber's salt 9 to 14 feet thick overlain by 3½ feet of clay; the latter protects the sulphate from dissolving in the water, which attains a maximum depth of 6 feet. The area, originally an old lake bed, was ordinarily dry until irrigation in the vicinity caused it to fill up again. The deposits were worked more or less from 1885 to 1892, but there is no record of later production. However, fairly recent core drilling over a 25-acre tract on one of the lakes (Track Lake) determined the formation to be almost pure, containing about 41 percent anhydrous sodium sulphate and only slight amounts of calcium and magnesium salts. The final product analyzed 96 percent and was free from iron.

The three Downey Lakes, in Albany County, 22 miles southwest of Laramie, are credited by Jones[34] with reserves of 4 million tons of crude sodium and magnesium sulphates; apparently a chemical process for separating the two salts would be necessary to make them marketable, and the distance from railroad offers a further deterrent to early exploitation. A great many other saline occurrences have been reported in Wyoming, and this State is widely considered a dependable source of Glauber's salt in annual quantities many times greater than any production record so far attained.

33/ Hartford, Fred D., The Ups and Downs of Salt Cake: Chem. Markets, vol. 30, no. 6, June 1932, p. 536.

34/ Jones, C. H., Mineral Industry, 1920, p. 634.

Generated on 2024-09-18 01:37 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

DOMESTIC PRODUCTION

Inasmuch as sodium sulphate is marketed in several forms, it is rather a difficult commodity to report statistically. Production of byproduct salt cake is still the dominant factor in supply, but natural salts have replaced niter cake as the second leading domestic source of the compound. The production of Glauber's salt from natural deposits is combined in reports of the Bureau of Mines with that of anhydrous sodium sulphate, as the two cannot be separated without revealing confidential information as to operations of individual companies, but this difficulty is of steadily diminishing importance, as the relative proportion of anhydrous sulphate produced from natural sources recently has increased greatly. The biennial figures of the Bureau of the Census make no reference to natural production, and it is obvious that this is not included in the output of salt cake reported and probably not in the case of Glauber's salt. The production of niter cake, as reported by the Census, may be assumed to be a net addition to sodium sulphate supplies (though this may not be quite true of earlier years), but it seems likely that the outputs of anhydrous salt (rather small) and of Glauber's salt are derived, at least in major part, from salt cake or niter cake.

As recently as 1927 the output of byproduct salt cake followed rather closely that of hydrochloric acid, and there was some degree of correlation between the output of nitric acid and that of niter cake, but these relationships have been disturbed by the changes in methods of acid-making noted elsewhere. As indicated graphically in figure 1, which is based upon production figures reported by the Bureau of the Census, the production of hydrochloric acid (when translated into terms of 100-percent acid) still affords some indication of the course of salt-cake production, but the rapid introduction of synthetic methods for making nitric acid has eliminated any visible correlation with figures for niter cake, the output of which has dropped off very rapidly.

The two following tables show the Bureau of Mines production of natural sulphates and the Census figures for specified sodium compounds, and on a later page, under the heading Domestic Consumption, an attempt is made to combine the two sets of sodium sulphate production figures with foreign trade data.

Production of natural sodium sulphates (salt cake and Glauber's salt)

(Compiled by A. T. Coons, of the Bureau of Mines)

Year	Short tons	Value	Year	Short tons	Value
1920	14,851	$221,123	1927	23,080	$168,882
1921	4,900	8,500	1928	6,580	42,485
1922	5,015	36,155	1929	7,540	41,199
1923	10,080	100,000	1930	32,630	206,323
1924	16,200	174,600	1931	32,510	198,132
1925	9,940	84,380	1932	32,204	210,342
1926	19,620	166,800	1933	46,539	245,240

Generated on 2024-09-18 01:44 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

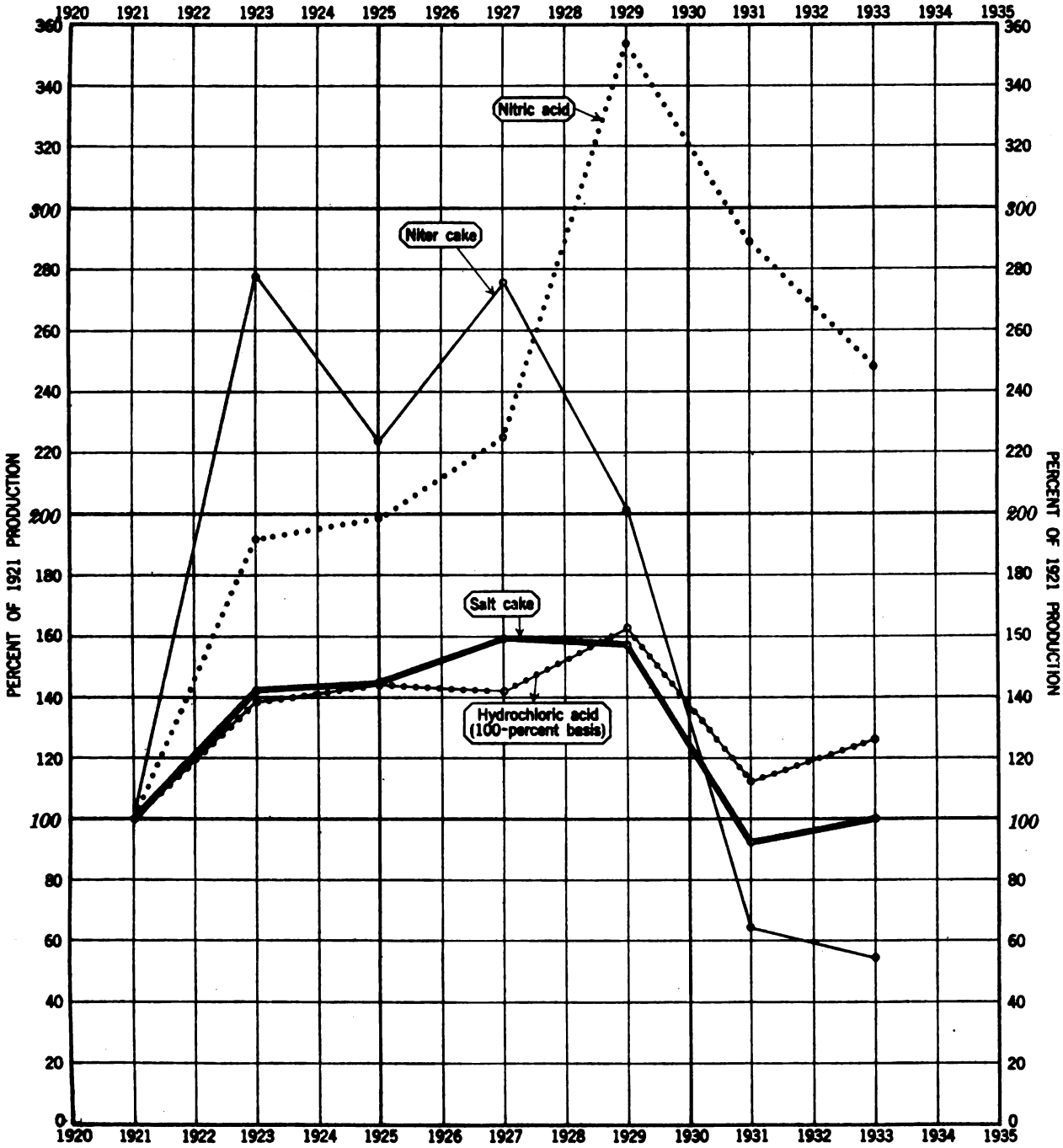

Figure 1.—Production of byproduct salt cake vs. hydrochloric acid (100-percent basis) and production of niter cake vs. nitric acid, expressed in percent of 1921 output, as reported by U.S. Bureau of the Census.

Generated on 2024-09-18 01:39 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 01:43 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access use#pd-google

(Census of Manufactures)

	1933[1]	1931	1929	1927	1925	1923	1921	1919	1914
Sulphates:									
Anhydrous:									
Number of establishments:	--	6	(2)	5	5	6	4	6	--
Tons	15,660	7,609	(3)	2,688	2,100	3,183	2,019	2,708	(4)
Value	$273,867	$169,717	(2)	$119,111	$128,115	$267,518	$153,954	$221,232	--
Glauber's salt:									
Number of establishments:	--	20	20	20	22	21	21	27	20
Tons	37,000	48,899	61,953	53,420	57,622	66,192	52,041	38,330	34,537
Value	$560,066	$847,424	$1,112,267	$1,081,980	$1,265,260	$1,521,095	$1,288,987	$864,264	$427,808
Hyposulphite(thiosulphate):									
Number of establishments	--	7	7	8	12	11	10	9	--
Tons	18,211	23,512	25,020	23,574	23,982	22,538	17,826	29,678	(4)
Value	$763,476	$969,206	$906,369	$992,865	$1,051,068	$1,124,351	$1,202,870	$1,541,087	--
Niter cake(bisulphate):									
Number of establishments	--	28	46	53	42	45	38	38	31
Total production, tons	30,558	35,680	111,522	153,615	124,296	154,087	55,578	97,836	46,143
Made and consumed in same establishment, tons	13,546	5,019	28,839	33,109	22,700	24,640	6,613	16,666	22,014
For sale, tons	17,012	30,661	82,683	120,506	101,596	129,447	48,965	81,170	24,129
Value	$352,512	$563,872	$1,023,136	$625,049	$400,598	$587,897	$274,161	$281,476	$31,5[illegible]0
Salt cake:									
Number of establishments	--	23	28	34	38	34	30	34	29
Total production, tons	131,622	119,399	206,612	208,565	189,293	187,064	131,701	179,003	110,263
Made and consumed in same establishment, tons	28,538	20,672	36,436	33,573	48,450	46,047	35,706	56,095	19,821
For sale, tons	103,084	98,727	170,176	174,992	140,843	141,017	95,995	122,908	90,442
Value	$1,351,604	$1,528,032	$2,014,838	$2,786,818	$2,339,002	$2,972,013	$2,046,314	$1,930,139	$841,887
Sulphide:									
Number of establishments	--	14	18	16	15	19	14	17	5
Tons	30,732	23,268	33,032	38,446	23,765	31,838	22,682	35,178	20,263
Value	$1,353,886	$1,032,811	$1,406,606	$1,691,609	$1,203,332	$2,209,499	$1,740,153	$2,316,253	$516,644
Sulphite(normal):									
Number of establishments	--	8	6	6	7	4	7	8	5
Tons	3,372	6,437	5,970	5,030	4,492	4,382	3,442	7,209	--
Value	$266,339	$568,892	$462,072	$399,529	$382,728	$370,601	$328,376	$539,636	$66,649

1/ Preliminary figures - subject to revision. 2/ Not tabulated separately. 3/ No data. 4/ Figures not available.

2779

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

IMPORTS

The imports of salt cake and niter cake and even those of Glauber's salt for many years were so small as to be insignificant. So long as domestic consumption scarcely equaled the byproduct output of these items there was little incentive to bring them in from abroad. After about 1925, however, imports of salt cake began to increase rapidly. By 1927 they amounted to nearly 5 percent of the visible supply, and in later years their relative importance increased greatly, until in 1933 they constituted over 30 percent.

Due to the fact that it is highly corrosive to containers, large amounts of niter cake have never been imported, and the imports of other sodium compounds allied to sodium sulphate have been rather small, even in recent years, as the following table indicates:

Imports for consumption of sodium sulphate and allied compounds, 1925-29 and 1933

Sodium compound	1925-29 (Average)		1933	
	Short tons	Value	Short tons	Value
Salt cake	27,843	$253,624	89,269	$885,306
Niter cake	5	144	(1)	40
Bisulphite and metabisulphite	703	33,893	1,094	39,192
Sulphate, anhydrous	2,711	60,404	10,371	179,529
Glauber's salt	3,214	34,766	629	8,677
Sulphide:				
Not more than 35 percent	403	18,175	264	8,746
More than 35 percent	3,823	148,647	704	27,205
Sulphite	427	25,035	72	4,728
Thiosulphate	40	1,526	68	2,146
Hydrosulphite, etc.	143	59,197	241	64,526

Whereas the imports of salt cake have increased, there has been a noteworthy decline in the imports of Glauber's salt, accompanied by an even more noteworthy increase in the importations of refined anhydrous sodium sulphate (which can be considered double-strength Glauber's salts. Changes in the relative proportions of these three important items over a period of years are indicated below:

Generated on 2024-09-18 01:38 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Imports for consumption of salt cake, refined sodium sulphate, and Glauber's salt, 1910-33

Calendar year	Salt cake		Refined (anhydrous) sodium sulphate		Glauber's salt	
	Short tons	Value	Short tons	Value	Short tons	Value
1910-14[1]	3,275[2]	$35,492[2]	(3)	(3)	305	$5,508
1919	--	--	(3)	(3)	--	--
1920	115[2]	2,833[2]	(3)	(3)	1	36
1921	185[2]	4,643[2]	(3)	(3)	3,107	27,179
1922	714	8,537	(3)	(3)	6,818	74,155
1923	5,283	84,051	84	648	9,013	100,145
1924	3,427	40,582	132	4,443	6,428	68,315
1925	1,913	18,176	136	3,700	6,682	77,150
1926	6,269	66,321	1,413	35,946	3,530	38,303
1927	11,172	100,279	2,877	65,695	3,145	31,210
1928	28,228	253,553	3,578	79,742	1,550	17,651
1929	91,633	829,793	5,552	116,935	1,161	9,517
1930	70,337	800,432	9,934	200,143	1,156	9,241
1931	72,746	803,509	10,315	193,041	924	9,615
1932	61,124	644,074	8,855	153,612	304	2,848
1933	99,269	885,306	10,371	179,529	629	8,677

1/ Average (fiscal years ended June 30). Imports of salt cake were abnormally large around 1911; only about 200 tons were imported in 1913 or 1914.
2/ Includes niter cake.
3/ Not reported separately.

Both Glauber's salt and anhydrous sulphate have been imported from Germany, and Germany is ordinarily one of the principal sources of salt cake. According to the Tariff Commission,[35] imports of salt cake in 1927 came chiefly from Canada, which supplied 44 percent of the imports in that year. A large part of the imports from Canada, originating in Saskatchewan, was entered through North Dakota and used by paper and glass manufacturers in the West. Germany and the Netherlands each supplied 28 percent of the imports in 1927, most of which were entered through New Orleans and consumed by the kraft paper industry in the Gulf States. In 1928 Germany and the Netherlands were the chief sources of imports, supplying 33 and 58 percent, respectively, and Canada dropped to third place. Imports of salt cake for later years are shown by countries of origin in the accompanying table. Although Belgium has an expert surplus of local origin the imports from the Netherlands probably comprise transshipments of German synthetic sodium sulphate.

Inasmuch as competition between foreign and domestic salt cake in many consuming markets hinges so largely on transportation charges the data of imports by customs districts, as shown in another table, are of considerable interest.

35/ U. S. Tariff Commission, Summary of Tariff Information, 1929: Sched. 15, p. 2590.

Generated on 2024-09-18 01:36 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 01:46 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Sodium sulphate - crude (salt cake); imports for consumption, by countries, 1927-33

Country	1927	1928	1929		1930		1931		1932 1/		1933 1/	
	S. tons	S. tons	S. tons	Value	S. tons	Value	S. tons	Value	S. tons	Value	S. tons	Value
Belgium	--	--	2,022	$18,642	8,811	$128,301	8,453	$78,677	16,156	$161,627	35,610	$330,114
Canada	4,945	2,734	2,545	21,638	8,897	94,260	19,246	188,687	7,980	77,193	12,423	109,329
Germany	3,125	9,168	34,810	316,242	29,333	312,171	39,620	469,308	32,054	356,279	38,110	354,246
Netherlands	3,102	16,325	50,837	459,220	5,236	46,754	4,694	60,894	3,578	38,880	4,063	37,426
United Kingdom	--	--	292	2,067	--	--	129	1,634	--	--	--	--
Mexico	--	--	--	--	--	--	--	--	--	--	25	179
Sweden	--	--	1,127	11,984	3,389	48,759	--	--	--	--	--	--
Chile	--	--	--	--	4,964	75,064	--	--	--	--	8,564	51,176
Spain	--	--	--	--	9,423	90,707	603	4,309	1,355	10,095	474	2,836
Hungary	--	--	--	--	280	4,416	--	--	--	--	--	--
Total	11,172	28,227	91,633	$829,793	70,335	$800,432	72,746	$803,509	61,124	$644,074	99,269	$885,306

1/ General imports.

Note: In 1933 less than 1 ton of niter cake valued at $40 was imported from the United Kingdom, and 629 tons of Glauber's salt valued at $8,677 were imported from Germany.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 01:41 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Customs district	1927	1928	1929		1930		1931		1932 1/		1933 1/	
	S. tons	S. tons	S. tons	Value	S. tons	Value	S. tons	Value	S. tons	Value	S. tons	Value
Gulf ports:												
Florida	--	--	--	--	--	--	8,775	$123,504	11,733	$135,446	13,434	$134,058
Mobile	--	--	10,082	$91,477	10,597	$106,200	19,618	195,602	17,393	184,980	20,801	174,880
New Orleans	3,848	9,055	14,710	125,428	12,355	149,982	8,774	90,561	14,793	141,744	28,768	256,509
Sabine	--	--	8,012	72,919	1,045	9,437	--	--	--	--	806	6,911
Galveston	100	10,028	25,612	226,983	2,822	25,500	--	--	--	--	336	2,983
San Antonio	--	--	--	--	--	--	--	--	--	--	25	179
Total	3,948	19,083	58,416	$516,807	26,819	$291,119	37,167	$409,667	43,919	$462,170	64,170	$575,520
Pacific ports:												
Washington	--	--	2,983	$28,193	7,497	$70,391	3,505	$47,126	3,137	$38,478	4,155	$50,525
Oregon	--	--	2,738	44,008	7,525	88,480	6,737	92,721	4,488	52,961	8,371	84,364
Total	--	--	5,721	$72,201	15,022	$158,871	10,242	$139,847	7,625	$91,439	12,526	$134,889
Atlantic ports:												
Maryland	2,278	3,258	5,944	$56,488	4,489	$59,352	1,782	$20,613	1,512	$12,941	2,402	$19,333
New York	--	--	1	15	4,630	71,762	53	826	--	--	5,973	30,642
Philadelphia	--	--	--	--	--	--	--	--	--	--	1,102	9,921
S. Carolina	--	--	--	--	2,107	26,880	--	--	--	--	--	--
Massachusetts	--	--	--	--	28	441	--	--	--	--	--	--
Virginia	--	--	14,963	126,893	3,121	28,972	3,661	36,249	453	3,931	672	5,672
Georgia	--	--	--	--	--	--	595	7,620	--	--	--	--
Total	2,278	3,258	20,908	$183,396	14,375	$187,407	6,091	$65,308	1,965	$16,872	10,149	$65,568
Canadian border:												
Dakota	4,945	2,656	2,545	$21,638	6,541	$63,488	19,049	$186,294	7,292	$71,500	7,591	$74,705
Mont. & Idaho	--	--	--	--	--	--	--	--	208	1,204	494	3,255
Duluth & Superior	--	--	--	--	1,564	20,483	197	2,393	96	834	4,338	31,369
Michigan	--	--	--	--	572	7,478	--	--	--	--	--	--
Buffalo	--	--	--	--	692	5,203	--	--	--	--	--	--
Maine & N. H.	--	--	4,043	35,751	4,530	63,572	--	--	20	55	--	--
Vermont	--	--	--	--	220	2,811	--	--	--	--	--	--
Total	4,945	2,656	6,588	$57,389	14,119	$163,035	19,246	$188,687	7,616	$73,593	12,423	$109,329
Other	1	3,230	--	--	--	--	--	--	--	--	--	--
Grand total	11,172	28,227	91,633	$829,793	70,335	$800,432	72,746	$803,509	61,124	$644,074	99,269	$885,306

1/ General imports.

2779

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

TARIFF HISTORY

Salt cake and niter cake have been on the free list of the various tariff acts since 1913. Refined anhydrous sodium sulphate and Glauber's salt are dutiable under the Tariff Act of 1930 at $3 and $1, respectively, a long ton. The rate on Glauber's salt has remained unchanged since 1909, but that on anhydrous sulphate, previously classed with Glauber's salt, was raised from $1 to $2 by the 1922 act prior to the further increase in 1930. Before 1913 these commodities were grouped with salt cake and niter cake, and the rates varied from 20 percent ad valorem to a specific rate of $1.25 a long ton.

Question has arisen as to whether the synthetic sodium sulphate produced in Germany should be classified as salt cake or as refined sulphate, but it has continued to be admitted free of duty. Under earlier acts confusion likewise arose, as "calcined sodium sulphate" was not classified with Glauber's salt or salt cake. For customs purposes "anhydrous" sodium sulphate has been defined as "practically free from water" and containing not less than 96 percent Na_2SO_4, not more than 0.09 percent iron and aluminum oxides, not more than 0.2 percent water-soluble material, and not more than 0.05 percent acidity (calculated as H_2SO_4) on titrating with methyl red as an indicator.

EXPORTS

Sodium sulphates were not separately recorded in the export statistics of the United States until 1929, but the existence of substantial trade with Canada is indicated by the foreign trade records of the Dominion, which show in 1928, for example, imports of 30,000 tons of salt cake, 36,600 tons of niter cake, and 53 tons of Glauber's salt from the United States. Some of the salt cake so recorded may have constituted European material shipped via American ports and thence by rail, but undoubtedly the niter cake was actually of American origin. It is probable also that some quantities of American salt cake were shipped to Scandinavian countries; in fact, some of the earlier proposals for opening natural deposits in the Southwest were predicated upon projected sales to Swedish pulp mills.

Since 1929 the United States, although importing large quantities of sodium sulphate, has been exporting substantial quantities, as shown by the tables that follow:

Exports of specified sodium compounds from the United States, 1929-33

	Sulphate		Niter cake	
	Short tons	Value	Short tons	Value
1929	1,666	$53,176	(1)	(1)
1930	4,436	113,253	(1)	(1)
1931	4,652	75,784	13,351	$147,901
1932	1,435	24,155	686	9,959
1933	--	--	--	--

1/ Not reported separately prior to 1931.

Generated on 2024-09-18 01:44 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Domestic exports of sodium sulphate, by countries, 1929-32[1/]

	1929		1930		1931		1932	
	S. tons	Value	S. tons	Value	S. tons	Value	S. tons	Value
Canada	1,247	$28,574	3,785	$73,286	3,265	$46,988	1,159	$15,596
Mexico	44	2,517	28	2,148	57	1,448	19	814
Cuba	148	5,083	248	6,130	182	3,573	134	2,600
Argentina	55	5,430	56	5,143	3	596	1	150
Colombia	16	865	20	2,272	33	2,388	18	695
Venezuela	11	699	22	1,395	46	1,564	38	1,233
Japan	64	3,307	25	3,015	1,014	13,034	2	296
Other	81	6,701	252	19,864	52	6,193	64	2,771
Total	1,666	$53,176	4,436	$113,253	4,652	$75,784	1,435	$24,155

1/ Figures not shown separately for 1933.

THE INDUSTRY IN FOREIGN COUNTRIES

Germany is the dominant factor in international trade in salt cake and dominates the cartel (Sulfat Syndikat) which has its headquarters at Frankfurt-am-Main. Other European industrial countries - notably Great Britain, France, and Belgium - with exportable surpluses have frequently pooled their interests with Germany to the extent of allocating markets and even operating through a joing sales organization. Natural deposits in Canada and more recently in Chile and Russia are becoming increasingly important.

Canada

The consumption of sodium sulphate in Canada has grown quite rapidly, but not until very recently did domestic production furnish any considerable portion of the requirements. The output from byproduct sources has never been large, and no production from natural deposits was reported prior to 1920. The alkali sloughs of Saskatchewan, the great grain-growing province of the Dominion, were investigated during the World War as possible sources of potash but, this element being absent in commercial quantities, they would have been virtually forgotten had not the Mines Branch at Ottawa continued investigations with a view to utilizing them. A number of lakes in Saskatchewan and Alberta were drilled, and extensive reserves of mirabilite and associated salts were proved up. There are 200 or more known deposits, and the 20 largest are estimated to contain 110,712,000 tons. Starting in a small way, the industry remained stationary as regards production until 1930, when the output of natural sodium sulphate jumped from a recent average of around 6,000 tons annually to around 35,000 tons. In 1929 a fire destroyed the mill at the deposit at Dunkirk, Saskatchewan operated by the Bishopric & Lent Co., of Cincinnati, Ohio (National Sodium Products Co., Ltd.), but this mill was rebuilt promptly, and the Horseshoe Lake Mining Co. installed

Generated on 2024-09-18 01:39 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

a plant near Ormiston, Saskatchewan, to harvest and dry crystals at a rate of 25,000 tons of dry product yearly. This plant has shipped principally to Copper Cliff, Ontario, where Canadian Industries, Ltd., converts the salt cake to niter cake for use by the International Nickel Co. in its Orford process for separating nickel and copper. During 1929, 80,872 tons of niter cake were imported into Canada for this purpose. The Horseshoe Lake operation was more or less inactive in 1931 and 1932, due to conditions in the nickel market, but sales to pulp and paper makers in Canada and the United States continued to grow, and with resumption of demand for nickel refining the output of salt cake in Saskatchewan made healthy progress, being valued at $485,416 in 1933. Preliminary figures for the first 6 months of 1934 show a production of 27,689 tons valued at $209,409.

Plants have been installed at Muskiki Lake, Frederick Lake, Fusilier Lake, Sybout Lake, Whiteshore Lake, Horseshoe Lake, and Alsask Lake. In addition, a plant is installed at Little Manitou Lake for processing mineral salts used for medicinal purposes. Another plant was erected at Senlac for reccvering sodium chloride.

Analyses show that the majority of the depcsits contain sodium sulphate, but in one or two cases, such as Muskiki Lake and Lucky Lake, a fair proportion of magnesium sulphate is in evidence. A new plant is being installed in Regina for processing the salts from Little Manitou Lake, which, when put on the market for medicinal purposes, will compare very favorably with other such medicinal salts.36/

Sundry revisions have been made in the list of operating companies from time to time, and several new concerns are currently reported as ready to enter the field; but the activities of the leading companies during 1933 are thus described in a recent consular report:37/

> Natural Sodium Deposits Limited of Dunkirk, Saskatchewan, have doubled their plant capacity and are operating night and day. Horseshoe Lake Mining Company, at Ormiston, Saskatchewan, after being closed during the whole of 1932, have been operating to capacity since the middle of August. Sodium Corporation Limited, Alsask, Saskatchewan, operated steadily throughout the year and are erecting a new plant which will have an ultimate capacity of approximately four times that of their original plant. Soda Deposits Limited, at Fusilier, Saskatchewan, have redesigned their plant and expect to operate steadily next year. Metallics and Non-metallics, Limited, a Toronto company, are to erect a sodium-sulphate plant to develop the Engebright deposit north of Maple Creek. This deposit is alleged to contain more than 25,000,000 tons of hydrous sodium sulphate.

36/ Canadian Mining Journal, Saskatchewan: Vol. 54, no. 3, March 1933, p. 124.

37/ Calvert, J. S., U. S. Consul, Regina, Saskatchewan Sodium Sulphate Developments: Bur. Foreign and Domestic Commerce, World Trade Notes on Chemicals and Allied Products, vol. 8, no. 6, Feb. 3, 1934, p. 3.

Generated on 2024-09-18 01:38 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

These developments virtually place Canada on a self-sustaining basis as regards sodium sulphate supplies and foreshadow a substantial exportable surplus. The 80,872 tons of niter cake imported in 1929 for use in nickel refining were roughly equivalent to 45,000 tons of salt cake, and another 45,000 tons of salt cake were needed for the sulphate pulp industry of the Dominion, of which nearly 40,000 tons were imported. Canadian imports of salt cake in 1933 totaled only 2,595 tons valued at $51,925; and those of niter cake had almost disappeared, amounting to only 895 tons valued at $13,237.

South America

Salt cake is a minor product or possible byproduct of sundry chemical-manufacturing operations in South American countries, and natural deposits at the base of the Andes have been worked for sodium sulphate (as well as borates) in Argentina and perhaps elsewhere. Chile, however, is now the only factor in international trade. Exports of sodium sulphate from Chile were begun late in 1929 and increased to 4,530 metric tons in 1930. Inasmuch as the sodium sulphate operations are associated with the nitrate industry, the liquidating commission of Cosach concerned itself with finding markets, giving especial attention to Scandinavia and the United States. The Chilean product is partly crude sulphate, which is found near the surface, frequently overlying nitrate, and partly as a byproduct of purifying sodium nitrate, as indicated in the following consular report,[38] describing the state of the industry in 1933:

> The production of sodium sulphate in the Aguas Blancas district, 95 kilometers east of Antofagasta, is at present 2,000 tons a month. This is crude sulphate averaging 85 percent sulphate and 15 percent other impurities, mostly solids. A small percentage of the latter is iodine, which is detrimental in making certain kinds of glass.
>
> The product is found on the surface in powdered form and is mined by hand labor using pick, shovel, and screen. At present four Chilean firms are digging sulphate in the district adjacent to the railway, the largest producer having a production of about 1,200 tons a month. Motor trucks are used to haul the sulphate to the railway, and it is shipped from Antofagasta in 100-pound bags to Atlantic ports in the United States. During the last five months exports of crude sodium sulphate have been: United States, 3,789 tons, and Europe, 105 tons.
>
> In the new plant of the Anglo Chilean Nitrate Company at Maria Elena the output of anhydrous sodium sulphate is averaging 5,000 tons monthly. This is a byproduct of the sodium nitrate plant, the sulphate being taken from the mother liquor in decahydrated form and the water extracted from the crystals by chemical treatment reducing the weight 50 percent.

38/ Lóren, Odin G., Vice Consul, Antofagasta., Sodium Sulphate in Chile: World Trade Notes on Chemicals and Allied Products, Bur. For. and Dom. Commerce, vol. 7, no. 30, July 24, 1933, pp. 1-2.

Generated on 2024-09-18 01:35 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Exports are in bulk and go largely to Sweden, where they displace German sulphate in paper making. Exports during the March-May period totaled 13,315 tons.

The Anglo Chilean Nitrate Company is planning the erection of a refining plant in Antofagasta to handle crude sulphate from the Aguas Blancas district. This plant will have a capacity of 10,000 tons monthly. A considerable expense is expected to be saved in housing and feeding workmen who have their homes in Antofagasta. It is planned to use the buildings of a subsidiary company, the Lautaro Nitrate Company, in Antofagasta for this refinery.

Two smaller producers have under consideration the construction of refining plants, but the plan is to build these near the deposits. It is claimed that this will save considerable in inland freight costs and will enable also working of lower grade deposits.

Europe

Natural sodium sulphate occurs in various European localities and has been produced commercially in Italy, Spain, Russia, and perhaps elsewhere, but only in relatively negligible quantities. Byproduct salt cake is made in all the leading heavy chemical manufacturing nations, but the dominant factor in European supply is Germany, where a large part of the output is synthetic sodium sulphate made at potash works. Virtually all of the European countries, however, can produce more than their own requirements of sodium sulphate, except members of the Scandinavian group, which are large importers due to the heavy demands of their important pulp industries and a dearth of supplies of common salt or other sodium compounds that could be utilized economically for the manufacture of salt cake domestically.

The following brief review of conditions in specified European countries is compiled from notes abstracted from numerous reports released during the last several years by the Chemical Division of the Bureau of Foreign and Domestic Commerce:

Belgium

Salt-cake capacity in Belgium is estimated around 60,000 tons, of which scarcely two thirds has been utilized in recent years. There is only a small balance of exports over imports, and domestic consumption has dropped from about 100,000 tons in 1913, largely because of the substitution of soda ash for sodium sulphate in the manufacture of window glass. Following the termination of trade agreements with the French potash industry, however, exports in 1933 registered a sharp advance, notably those to the United States.

Generated on 2024-09-18 01:42 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Czechoslovakia

About 25,000 tons of Glauber's salt are annually produced in Czechoslovakia, principally by the Aussiger Verein, as the 14 other plants contribute only small quantities. The fact that imports are tending to exceed exports may indicate that the German product is gaining headway even in the Czech home market.

Finland

Approximately 90 percent of Finland's requirements of sodium sulphate are obtained from abroad, imports in 1931 amounting to 41,975 metric tons. In October 1932 the price of bulk salt cake was reported to be 60 shillings or around $10.20 per long ton, c.i.f. Finnish port.

France

The French output of sodium sulphate, amounting to 135,000 metric tons in 1929, rises and falls in accordance with demand from local glass works. Shipments have been made to Sweden, but the industry depends mainly upon home markets, and the joint output of hydrochloric acid in France is likewise limited by the demand for salt cake.

Germany

The German production of sodium sulphate and niter cake has been estimated as high as 350,000 tons annually. The Kaiseroda works alone have a capacity of 120,000 tons, and the I. G. plants (1928 figures) are credited with an ability to make 80,000 tons annually, to which may be added the possible output of Chemische Fabrik Kalk, of Cologne, and Kali-Chemie A. G. (Rhenania-Kunheim) of Berlin, which can furnish 18,000 tons each.

German exports rose rapidly to 177,374 metric tons in 1929 and continued upward to 188,390 tons in 1930. In 1933, the exports were 131,374 metric tons, valued at 5,046,000 marks; the United States, Sweden, and Finland were the leading destinations. Imports, principally from Czechoslovakia, are negligible.

Great Britain

Exports of sodium sulphate (including salt cake) from Great Britain rose from 70,000 short tons in 1926 to a record high of 133,700 tons in 1929, dropping to 60,600 in 1930 and 39,200 in 1931. Domestic production is roughly indicated by annual reports of the British Alkali (and Other) Works' Inspectors' reports, which state that 53,648 long tons of salt were decomposed in the salt-cake process in 1932 and 56,473 tons in 1933; these figures indicate an output of around 70,000 tons of salt cake from this source in these years. Synthetically produced acid now can meet almost the entire requirements of hydrochloric acid in Great Britain (as well as in other countries), and accordingly the decomposition of salt by sulphuric acid is seldom practiced any more except where salt cake is required.

Generated on 2024-09-18 01:36 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Sweden

Imports of sodium sulphate into Sweden have grown rapidly in recent years, reflecting increased output of sulphate pulp. In the early 1930's they averaged around 100,000 tons a year compared with an average of 71,600 tons annually for the period 1925-8.

U. S. S. R.

Hirsch39/ reports that natural deposits of sodium sulphate at Karabugez are of great interest; they contain 2 billion tons and are of highest purity, free from magnesium salts. Mirabilite has elsewhere been reported on both west and east shores of the Caspian Sea and in former Asiatic Russia, in various lakes south of the Trans-Siberian railway and along the Yenisei River, notably Lakes Altai and Domoshakovo. Recently Russia has become an export factor of some importance.

DOMESTIC CONSUMPTION

The consumption of salt cake has increased rapidly, due largely to the growing demand from sulphate pulp mills. The production of sulphate pulp (used mainly for kraft paper) in the United States advanced from 52,641 short tons in 1914 and only 412,690 tons in 1925 to 922,674 tons in 1929 and 1,036,113 tons in 1931; a sharp decline in 1932 was followed by an increase to over 1,234,000 tons in 1933. This is now by far the principal outlet for salt cake both in this country and in Canada, which ships large quantities of sulphate pulp to the United States. As much as 1/4 ton of salt cake may be used per ton of sulphate pulp produced, but the average consumption for this purpose is obviously somewhat less than this, perhaps a 1:5 ratio.

In the following table an attempt is made to make a quantitative estimate of the consumption of sodium sulphate in various forms in the United States, but the tabulation suffers from the uncertainty regarding exports prior to about 1929, when they were first listed separately in the Foreign Commerce and Navigation of the United States. A minor discrepancy is the inclusion of some hydrated salt in the domestic production figures for natural sodium sulphate. Moreover, no account is taken of the imports of Glauber's salt and of refined (anhydrous) sodium sulphate.

39/ Hirsch, Alcan, Chemical Progress in the U. S. S. R.: Chem. and Met. Eng., vol. 39, no. 11, November 1932, pp. 590-3.

Generated on 2024-09-18 01:36 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Calculated domestic consumption of sodium sulphate, in short tons, 1919-33

Year	Domestic Production					Imports: Salt cake	Supply[3]
		Byproduct					
		Niter cake		Salt cake	Natural sodium sulphate		
	Glauber's salt [1]	Actual	Salt cake[2] equivalent				
1914	34,537	46,143	28,000	110,263	--	200	138,000
1919	38,330	97,836	58,000	179,003	--	--	237,000
1921	52,041	55,578	33,000	131,701	5,000	165	170,000
1923	66,192	154,087	93,000	187,064	10,080	5,283	295,000
1925	57,622	124,296	75,000	189,293	9,940	1,913	276,000
1927	53,420	153,615	92,000	209,565	23,080	11,172	335,000
1929	61,953	111,522	67,000	206,612	7,540[4]	91,633	373,000
1931	48,899	35,680	21,000	119,399	32,510	72,746	245,000
1933	37,000	30,558	18,000	131,622	46,539	89,269	285,000

1/ Since Glauber's salt is apparently made from salt cake, production is not included in total.
2/ Salt cake equivalent of niter cake estimated at 60 percent.
3/ Domestic production plus imports, estimated in terms of sodium sulphate, exclusive of Glauber's salt and H_2SO_4 content of niter cake, and neglecting exports, which were doubtless quite substantial before about 1929.
4/ Arizona not producing for 2 years.

MARKET AREAS

The natural sodium sulphate produced in Wyoming (Glauber's salt) is sold mainly for stock medicines in the Middle West, a rather limited market. Plants that require salt cake for making Glauber's salt and other heavy chemicals are mostly situated in the same territory as the acid plants that supply byproduct salt cake; in fact, such plants are quite often under the same ownership, if not actually under the same roof. Broadly speaking, the rayon and textile industries are in the same territory, and the same is true to a somewhat smaller extent with respect to glass works. The great tonnage of glass is made in the area comprising western Pennsylvania, West Virginia, Ohio, Indiana, and Illinois, region that is well-supplied with hydrochloric acid plants that can furnish salt cake. Foreign competition in much of this area is likely to be confined to Canadian imports, and freight considerations tend to rule out shipments of natural sodium sulphate from most of the deposits in the southwestern United States.

The output of sulphate pulp by States is not published by the Federal Census, but a clue to the situation is afforded by the fact that in 1929 more than 50 percent of the wood consumed for this class of pulp was Southern pine and that the bulk of the remainder was hemlock, which is used principally in

Generated on 2024-09-18 01:45 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Washington and Wisconsin, and jack pine, which is used mainly in Wisconsin. Obviously, the Wisconsin mills and possibly those in Washington tend to be accessible to Canadian natural salt cake from Saskatchewan, whereas the mills in Louisiana and other Gulf States and also Virginia are strategically located for receiving overseas shipments, chiefly synthetic German salt cake.

The consumption of salt cake in glass making is reported by the Bureau of Census (Census of Manufactures: 1929, p. 871) by States, and the figures are given in an accompanying table. Another table gives the estimated distribution of sulphate pulp production, thereby furnishing a rough indication of the probable relative importance of specified States as consumers of salt cake for this purpose. An additional sidelight on consumption in competitive market areas is afforded by the tabulation presented under Imports on a previous page, showing deliveries of foreign salt cake by ports of entry. In 1930, a decrease in imports at Galveston was accompanied by a corresponding increase in domestic sales of natural salt cake. Attention may also be drawn to increased imports at Pacific ports (from Germany) before production commenced at Searles Lake; previously the only domestic source in this area was one byproduct plant with a rather small output as compared to demand for kraft pulp makers on the Pacific Coast. The movement of Canadian material through North Dakota also is significant.

Consumption of salt cake and soda ash in the glass industry, in short tons, by States, 1929 and 1927[1]

State	Salt cake	Soda ash	State	Salt cake	Soda ash
United States:			New York:		
1929	47,284	678,461	1929	494	28,186
1927	42,607	604,048	1927	473	27,465
California:			Ohio:		
1929	95	29,171	1929	3,719	81,220
1927	314	19,568	1927	2,729	64,679
Illinois:			Oklahoma:		
1929	4,133	73,467	1929	1,166	15,937
1927	3,739	70,165	1927	814	13,259
Indiana:			Pennsylvania:		
1929	3,635	97,784	1929	14,575	161,471
1927	3,464	91,890	1927	14,717	148,400
Maryland:			West Virginia:		
1929	(2)	7,683	1929	9,809	103,936
1927	(2)	7,018	1927	7,684	92,735
New Jersey:			Other States:[3]		
1929	(2)	30,165	1929	[2] 9,658	49,441
1927	(2)	27,268	1927	[2] 8,673	41,601

1/ Census of Manufactures: 1929, p. 871

2/ Quantities reported for Maryland and New Jersey included in item for "Other States".

3/ In 1929: Alabama, Arkansas, Florida, Kansas, Louisiana, Michigan, Minnesota, Missouri, Rhode Island, South Carolina, Tennessee, Texas.

Generated on 2024-09-18 01:36 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Daily production of kraft pulp by States and summary showing kraft-pulp production by sections[1]

	Tons		Tons
Alabama	100	North Carolina	112
Arkansas	150	Oregon	60
Louisiana	650	Pennsylvania	50
Michigan	215	Texas	30
Minnesota	70	Virginia	200
Mississippi	120	Washington	600
Maine	175	Wisconsin	400

Summary

	Tons
Southern States	1,050
North Central and Eastern States	1,222
North Pacific States	660
	2,932

1/ La Marche, R. I. (Representing Manufacturers of Paper and Paper Products), Tariff Hearings, Ways and Means Committee, House of Rep., 70th Congress, vol. 15, Free List, pp. 9329-34.

PRICES

Salt-cake prices, in common with those of other rather bulky materials, vary considerably in different parts of the country because of the cost of transportation. The prices of natural Glauber's salt in Wyoming have generally ranged from $3 to $5 f.o.b. mine, and the anhydrous product in Arizona and Nevada has rarely fetched more than about $6 a ton in recent years. In 1933, the average value of byproduct salt-cake sales, as reported to the Bureau of the Census, was $13.10 a short ton whereas the average worth of the natural product was reported by producers as only $5.25. A certain amount of Glauber's salt is included in the latter figure, but the main reason for the discrepancy is the fact that byproduct plants are mostly situated close to markets whereas the Western natural material must absorb a considerable amount of freight before it reaches the consumer. Canadian sources are subject to a similar handicap, some of the material reported in the American import statistics being invoiced at under $7 a short ton. In the early years of the Canadian industry, prior to 1928, the average price reported by Canadian producers ranged from $2 to $6 a ton.

Generated on 2024-09-18 01:44 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Comparative cost of German and domestic salt cake on Pacific coast in 1929

(Source: American Sodium Co., Rhodes Salt & Borax Co., Sodium Products Corporation, and Westates Co. Brief. Tariff Hearings before Committee on Finance. U. S. Senate, 1929, Free List, p. 577)

	German	American byproduct	American natural
Railroad freight	$2.28	--	$7.50
Ocean freight	1/ 4.18	$2.50	--
Fees and insurance	.18	.05	--
Commission and incidentals	.16	.50	--
Sacking	1.90	2.25	2.25
Production costs	2/ 4.50	10.00	6.75
Total	13.20	15.30	16.50
German sales price	15.95	15.95	15.95
Profit	2.75	0.65	3/ 0.55

1/ Includes $1.20 Panama Canal tolls. 2/ Estimated. 3/ Loss.

Comparative cost of German and domestic salt cake on Gulf coast, in 1929

(Source: American Sodium Co., Rhodes Salt & Borax Co., Sodium Products Corporation, and Westates Co. Brief. Tariff Hearings before Committee on Finance. U. S. Senate, 1929, Free List, p. 577)

	German	American byproduct	American natural
Railroad freight	$2.38	1/ $7.00	$12.00
Ocean freight	2.70	--	--
Fees and insurance	.18	--	--
Commission and/or incidentals	.16	--	--
Production costs	2/ 4.50	10.00	6.75
Total	9.92	17.00	18.75
German price per ton, Gulf ports	13.50	13.50	13.50
Profit	3.58	3/ 3.50	3/ 5.25

1/ Average rail rate (Illinois, Missouri, or Ohio). 2/ Estimated. 3/ Loss.

Whereas byproduct producers generally have an advantage with respect to nearness to market, they have experienced uncertainties due to the peculiar circumstances under which they produce the product. Unless the equivalent output of hydrochloric acid can be marketed promptly the production of salt cake must stop. Even should market conditions justify wastage of the acid, the fumes could not be allowed to escape into the atmosphere and storage of any abnormal quantities of acid would entail prohibitive expense. Conversely,

Generated on 2024-09-18 01:44 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

a brisk demand for acid tends to pile up salt cake, a condition that formerly caused more alarm than it does at present when demand for salt cake may be expected soon to catch up with any reasonable production from existing by-product sources. Any long-time study of salt-cake prices, however, should recognize the fact that the output of byproduct material is profoundly influenced by the demand for acid and that the demand for acid quite often is out of balance with ups and downs of the paper and glass industries, the leading buyers of salt cake.

From 1910 to 1915 the prices of salt cake as reported for the New York market remained stationary within the range of $10 to $13 a short ton for ground material. After a brief drop to $8 early in 1916 the quotation promptly recovered and proceeded to rise fairly steadily to $40 late in 1918. After dropping to the pre-war level for a few months in 1919, it soared again, reaching a peak of around $45 (small lots being sold as high as $60) in 1920. The gyrations during the World War and subsequently in 1920 were due in large part to export demand from Swedish pulp mills unable to obtain normal supplies from Germany. The trough of the 1921 slump was $18, and this was followed by a fairly rapid rise to $28 in early 1923 and an almost equally rapid decline to around $16 in the summer of 1924. Beginning in 1925, due perhaps to the sustaining effect of increased demand from the kraft pulp industry, a considerable degree of stabilization developed around $18, but this was marred by a collapse in 1928 as German production was stepped up. By 1930, prices were well above the average for the previous 5 years, but as import offerings increased and even the kraft paper companies began to feel the depression the quotation drifted in 1932 to around $13, where apparently it met considerable resistance.

Niter cake was formerly valued mainly for its acid content and hence had to be sold locally or made into salt cake. Only in later years has it been quoted in trade journals. From $8 a ton in 1923, the price of niter cake, in bulk, f.o.b. works, dropped to $6, and subsequently, about the middle of 1925, to $4.50. Late in 1928 it jumped to $10 and later even higher. Shipments to Canada and continued decline in byproduct production were obvious factors in this market, and it is interesting to note that the average value of niter cake imports, as reported in Canadian Government returns, rose from $3.85 per ton in 1927 to $8.50 in 1928 and to $14.35 in 1930. The quantity began to drop off, however, in 1930, and in 1932 the tonnage was insignificant; the average value as reported was close to $20, but this high figure doubtless resulted from including some refined bisulphate.

Quotations at the beginning of each quarter are shown in accompanying tabulations, compiled from selected trade-journal sources by the U. S. Tariff Commission.

Generated on 2024-09-18 01:45 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Salt cake prices (wholesale) per ton, spot, New York
(U. S. Tariff Commission)

Year	January	April	July	October
1912	$11.00	$11.00	$11.00	$11.00
1913	11.00	11.00	11.00	11.00
1914	11.00	11.00	11.00	11.00
1915	11.00	11.00	11.00	11.00
1916	11.00	12.00	--	11.00
1917	--	--	--	30.00
1918	30.00	30.00	30.00	35.00
1919	25.00	18.00	12.00	14.00
1920	17.00	21.00	40.00	50.00
1921	25.00	25.00	17.00	17.00
1922	18.00	17.00	18.00	25.00
1923	25.00	25.00	25.00	24.00
1924	22.00	23.00	17.00	18.00
1925	18.00	20.00	18.00	20.00
1926	20.00	20.00	20.00	20.00
1927	20.00	18.00	18.00	18.00
1928	17.00	17.00	10.00	10.00
1929	15.00	15.00	15.00	18.00
1930	20.00	20.00	18.00	14.50
1931	14.50	14.50	17.00	16.00
1932	15.00	15.00	13.00	13.00
1933	13.00	13.00	13.00	13.00
1934	13.00	13.00	13.00	13.00

Niter cake prices per ton, bulk, at works, spot, New York
(U. S. Tariff Commission)

Year	January	April	July	October
1922	--	--	--	$6.50
1923	$8.00	$6.00	$6.00	6.00
1924	6.00	5.50	5.50	5.50
1925	5.50	5.50	4.50	4.50
1926	4.50	4.50	4.50	4.50
1927	4.50	4.50	4.50	4.50
1928	4.50	4.50	4.50	10.00
1929	12.00	14.00	14.00	14.50
1930	15.00	14.00	14.00	14.00
1931	14.00	14.00	14.00	14.00
1932	13.00	13.00	10.00	10.00
1933	10.00	10.00	10.00	12.00
1934	12.00	12.00	12.00	12.00

Generated on 2024-09-18 01:38 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Glauber's salt prices (wholesale) per 100 pounds, spot, New York
(U. S. Tariff Commission)

Year	January	April	July	October
1912	$0.60	$0.60	$0.60	$0.60
1913	.60	.60	.60	.60
1914	.60	.60	.60	.60
1915	.60	.60	.60	.60
1916	.60	.70	.65	.60
1917	.60	.60	.65	—
1918	.90	1.50	1.50	2.00
1919	1.75	1.50	1.00	1.25
1920	1.15	1.60	2.30	2.10
1921	1.75	1.75	1.50	1.75
1922	1.00	.95	.85	1.25
1923	1.25	1.25	1.30	1.35
1924	1.35	1.35	1.20	1.25
1925	1.25	1.25	1.25	1.20
1926	1.20	1.10	1.10	1.00
1927	1.10	1.10	1.10	1.10
1928	1.10	1.00	1.00	1.00
1929	1.00	1.00	1.00	1.00
1930	1.00	1.00	1.00	1.00
1931	1.00	1.00	1.00	1.00
1932	1.00	1.00	1.00	1.00
1933	1.00	1.00	1.00	1.00
1934	1.00	1.00	1.00	1.00

Glauber's salt prices (imported), bags, 100 pounds, spot, New York
(U. S. Tariff Commission)

Year	January	April	July	October
1925	--	--	--	$0.85
1926	$0.75	$0.85	$0.80	.70
1927	.90	.80	.70	.70
1928	.70	.70	.70	.70
1929	.70	.70	.70	.70
1930	.70	.70	.70	.70
1931	.70	.70	.70	.70
1932	.70	.70	.75	.75
1933	.75	.75	.75	.75
1934	1.05	1.05	1.05	1.05

Generated on 2024-09-18 01:39 GMT / https://hdl.handle.net/2027/osu.32435030644074
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY